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Neural Network Application for Classifying Beef Intramuscular Fat Percentage

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Abstract
In the previous report, we have presented statistical pattern recognition and classification techniques to preclassify the ultrasonic images into the low- or high- IFAT groups (less than 8% and more than 8%). The classification tree was used in the previous report, and it provided overall classification accuracy of 90% for low- and high- IFAT groups of images. Here, we are presenting artificial neural network (ANN) as a pattern recognition tool to get better classification accuracy. ANNs provide a nonparametric approach for the nonlinear estimation of data. These models are trained to mimic the desired behavior using example data from the actual problem. The ANN model provided classification accuracy of 95% for 653 sample images.

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Summary

In the previous report, we have presented statistical pattern recognition and classification techniques to pre-classify the ultrasonic images into the low- or high-IFAT groups (less than 8% and more than 8%). The classification tree was used in the previous report, and it provided overall classification accuracy of 90% for low- and high- IFAT groups of images. Here, we are presenting artificial neural network (ANN) as a pattern recognition tool to get better classification accuracy. ANNs provide a nonparametric approach for the nonlinear estimation of data. These models are trained to mimic the desired behavior using example data from the actual problem. The ANN model provided classification accuracy of 95% for 653 sample images.

Introduction

After the feature extraction and selection, we need a pattern classification tool to assign an input ultrasonic image to a specific class according to the characteristic features selected for it. In this report, we used Fourier transform and gradient methods for feature extraction, and we used correlation analysis to select the features. Finally, ANN models were used as a classification tool.

Artificial Neural Network (ANN)

A neural network has a certain number of simple processing elements called neurons (or perceptrons). Each one is connected to other neurons by means of direct communication links. Each link has an associated weight. The weights collectively represent information being used by the network to solve a problem. A neural network is characterized by its architecture, training, and activation function. Architecture describes the pattern of connections between neurons. Training indicates the methods used to determine the weights associated with each link. Typical activation functions are nonlinear, such as the sigmoid and hyperbolic tangent functions. The activation or internal state of a neuron is determined by the application of the neuron's activation function to the weighted inputs, resulting in an output signal as presented in figure 1.

Figure 1: An individual neuron

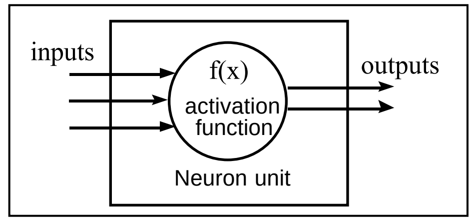


Figure 2: Multilayer perceptron architecture.

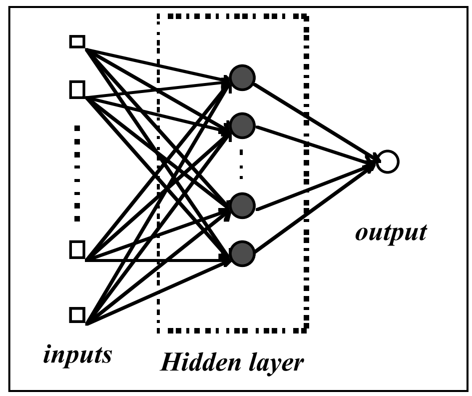
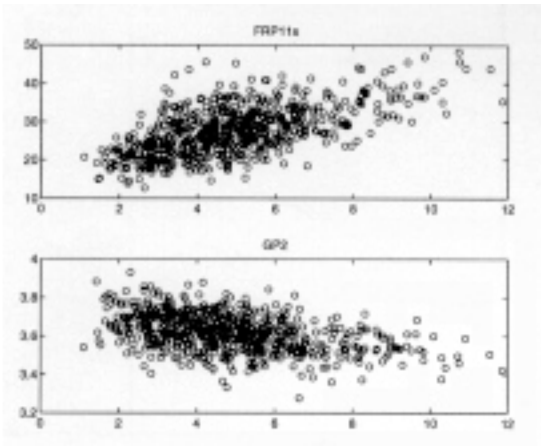


Figure 2 shows the multi-layer perceptron (MLP) with the Back-Propagation (BP) architecture that is used in this work. BP neural networks use a training method in which the difference between the actual network output and a supplied target output is back-propagated to adjust the network weights and reduce the error present. A typical MLP consists of three layers: input, hidden, and output layers. The input layer neurons receive their signals from an input vector. The hidden layer receives weighted inputs from the input layer neurons and processes these signals using an activation function. The hidden layer outputs are sent as weighted inputs to the output layer and are processed. The outputs of the output layer neurons are the outputs of the neural network.

Materials and Methods

Previous work has shown that overall prediction accuracy was improved by developing different regression models for low-IFAT (8% ≥) and high-IFAT (> 8%) groups. Artificial neural networks were developed using selected features for pre-classifying images into low fat and

Figure 3: The scatter plat of input samples against IFAT.



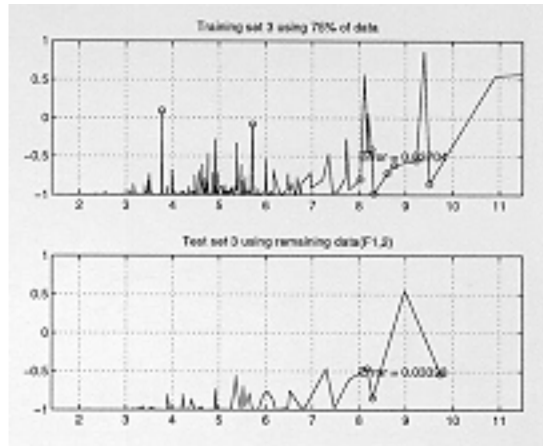
high fat. A multilayer perceptron (MLP) with a back-propagation (BP) algorithm was adopted in this work. The selected input features were FRP11s (one Fourier feature) and GP2 (gradient feature). Their distributions of input samples are shown in figure 3.

From our experience, a MLP with a BP network that has two hidden layers (the first has five neurons, and the second has three neurons) gives the optimum classification results for our data. Hence, our neural networks have two inputs (FRP11s and GP2), two hidden layers, and one output neuron. For developing models and validation testing the prediction of fat percentage, the image data (653 images) were divided into two groups. The first group, with about 75% of available images, was used in the training of the neural network model. The second group of remaining images was used for validation testing of the neural network.

Results and Discussion

An artificial neural network was developed as a pattern recognition tool to assign each sample to a class of less than 8% or more than 8% fat. Our neural networks provided a mean of 95% classification accuracy, whereas our previous tree-based classification gave 90% accuracy. Figure 4 shows one of the results of ANN with one set of data. The plots present the values of the output neuron for input features. The decision rule is to assign the low fat percentage group to the values less than 0, and the high fat percentage group to the values more than 0. The circles in the figure represent the misclassified samples. The upper plot shows the result of training, and the lower plot shows the result of ANN using the testing data set. As the plots indicate, most of the error occurs at the higher fat percentage group. We can apply the same reasoning as before; there is insufficient data in the higher fat percentage group to train the network properly.

Figure4: The result of MLP with BP algorithm using 75% of the training data.



Implications

A new pattern classification model, the artificial neural network (ANN), was introduced to investigate how it performs with our features of Fourier analysis and gradient methods. Neural networks learn about their environment through example, and thereby construct an input-output mapping that provides a solution. ANNs work better than previous tree-based classification methods. ANNs provide 95% classification accuracy for the low and high-IFAT groups.

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